UNSOLICITED PROPOSAL
FOR A
SLEEP RESTORATIVE TRAINER

INTRODUCTION

This section contains the Unsolicited Firm Fixed Price Proposal for a Sleep Restorative Trainer. This proposal was prepared by McDonnell Douglas Electronics Company for the United States Army.

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1. STATEMENT OF WORK

The McDonnell Douglas Electronics Company, a division of McDonnell Douglas Corporation, referred to herein as "Offeror" proposes to furnish materials, facilities, equipment and services of professional engineering and technical personnel to provide a Sleep Restorative Trainer utilizing a binaurall - sound sleep inducement process devised by the Monroe Institute of Applied Sciences (MIAS). A demonstration will be performed to enable the U.S. Army to evaluate the MIAS sleep inducement process in field exercises. A detailed Technical Proposal is provided as Appendix "A".

2. Firm Fixed Price

The contractor will perform the work described in Paragraph 2 above for an estimated Firm Fixed Price of ____________.
A detailed price breakdown is provided as Appendix "B".

3. DELIVERY AND PERFORMANCE

The Contractor will provide the proposed effort in accordance with the schedules provided by Appendix "C".

4. BASIS OF PROPOSAL

Validity - This price proposal assumes an October 1982 authority to proceed and is valid through this date. Contract award after October 1982 may require revision to this proposal to reflect economic consideration.

5. GOVERNMENT FURNISHED EQUIPMENT AND SUPPORT

The required GFE and Support are identified in Paragraph 8 of Appendix "A".

6. ROYALTY INFORMATION

The sleep inducement process proposed herein is covered in part or whole by MIAS-owned Patent #3,884,218. While no royalty payments are included in this proposal, it should be noted that in any future procurements of the Sleep Restorative Trainer, (SRT), MIAS may require royalty payments.

7. TEAMING AGREEMENT

MDEC has entered into a Teaming Agreement with Monroe Institute of Applied Sciences for the performance of the effort described herein. The SRT is based on the sleep inducement process covered by MIAS patent #3,884,218. If Contractor's agreement with MIAS is disapproved by the Government, this proposal will immediately be withdrawn by MDEC.

8. TERMS & CONDITIONS

The Contractor requests that the following clauses be included in any resulting Contract for the effort described herein:

APPENDIX "A"

TECHNICAL PROPOSAL

30 JUNE 1982

SECOND DRAFT

TECHNICAL PROPOSAL

FOR

SLEEP RESTORATIVE TRAINER

Development

and

Field Evaluation

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SUMMARY

This proposal describes a Sleep Restorative Trainer (SRT) jointly offered by McDonnell Douglas Electronics Company and Monroe Institute of Applied Sciences for the Army's consideration. The SRT is intended to alleviate the serious sleep discipline problem, with its attendant loss of combat efficiency, encountered by the Army decision making personnel during extended (continuous) combat operations.

The SRT is a solid-state unit designed by McDonnell Douglas Electronics Company (MDEC). It produces a binaural-sound sleep inducement process devised by Monroe Institute of Applied Sciences (MIAS) through many years of sleep research. The SRT will provide the Army with a unique technique by which a soldier can, through training, learn to develop a skill for using the relatively short periods during lulls in action to have sleep/rest cycles which will regenerate his alertness despite the stresses imposed by combat conditions. This ability is especially important for the command level soldiers since they must function "around the clock" during the continuous combat operations now possible with the recent advances in combat equipment.

A demonstration model SRT will be provided to enable the Army to evaluate the MIAS sleep inducement process in Army field exercises. The demonstration model can be available in less than seven months after go-ahead is given by the Army. During this time MIAS, in cooperation the Army, will devise a plan for a comprehensive evaluation of the SRT using standard or adapted Army training exercises. The evaluation results will be documented in a technical report, prepared by MIAS, 60 days after field evaluation completion.

For expedient evaluation, the demonstration model SRT will provide for simultaneous training of up to twenty soldiers and will require colocation of the trainees. However, the electrical design of the demonstration model SRT will be readily adaptable, with little circuit change, for use in a self-contained personal model SRT. While development of a personal model SRT is not a subject of this proposal, it is anticipated that such development will be initiated shortly after successful completion of the evaluation program. The personal model SRT will enable the Army to phase sleep inducement training in at all training levels for new soldiers (enlisted and officer) and to train, in-place, the present Army personnel.

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1. Introduction - This proposal presents to the Army a means for achieving the effective sleep discipline needed to maintain individual soldier combat effectiveness on a 24-hour, 7-day-a-week basis. A Sleep Restorative Trainer (SRT), described herein, is offered for the Army's consideration. The SRT, plus its field evaluation, is a joint endeavor of the McDonnell Douglas Electronics Company (MDEC) and the Monroe Institute of Applied Sciences (MIAS). It combines the results of many years of sleep-inducement research by MIAS and the latest solid-state electronics technology developed by MDEC.

The SRT described in this proposal provides a unique technique by which a soldier can, through training, learn how to develop a skill for using relatively short periods during lulls in action to have sleep/rest cycles which will regenerate his alertness. With the MDEC/MIAS SRT technology described here it is feasible for the individual soldier to learn to have deeply restorative sleep/rest cycles of less than thirty minutes.

2. System Concept - The MDEC/MIAS system concept presented here is intended to alleviate the sleep discipline problem emphasized in the document "Soldier Performance in Continuous Operations"[1] which was available for study in coordination copy form. This problem, as presented in the document, is paraphrased in summary form in the following two paragraphs.

"Continued technical advances in weapons and weapons systems have provided the means for sustained around-the-clock combat operation which destroys the individual soldier's normal wake/sleep cycles in addition to imposing

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[1] This report was prepared by Applied Psychological Services, Inc., in collaboration with U.S. Army Research Institute for the Behavioral and Social Sciences, and the U.S. Army Soldier Support Center.

the usual battle stresses. After 48 hours, the total loss of sleep becomes very damaging, severely degrading the soldier's performance of his combat tasks. The adverse effects of such sleep loss cannot be offset by sheer determination alone and an effective sleep discipline becomes a battlefield necessity."

"Sleep discipline for continuous combat requires implementation of a well-developed, unit-specific plan of sleep and rest. The plan must, through use of duty rotation and shift work, provide a framework for imposition of sleep routines in combat. The ability to sleep and waken, at will, is an essential and integral part of any program of sleep discipline. The soldier must be able to fall asleep quickly and become awake and alert just as quickly when he is again needed."

Prior MIAS studies of civilians have shown that the ability to fall asleep quickly, and awaken as easily can be both learned and improved with training and practice through use of a MIAS sleep inducement process. The MDEC/MIAS team proposes to incorporate this process into an SRT adapted for Army use. The Army could then employ the SRT during normal combat training to teach the individual soldier to fall asleep rapidly at will and to waken with equal ease.

The SRT uses a binaural/stereo sound process developed by MIAS. Early research by MIAS culminated in Patent #3,884,218 which is based upon the use of complex sound waves to induce frequency following response (FFR) in the brain. When the ear detects particular types of sound signals, similar electrical signals in the brain tend to be enhanced or "resonate" with the

sound waves. This effect is the frequency following response. The various states of consciousness (awake/asleep/deep rest) are accompanied by certain electrical brain wave patterns. Listening to sound patterns similar to the brain wave patterns can help induce these same states of consciousness.

Later MIAS research advanced sleep-inducement technology a further important step by exploitation of the Hemispheric Synchronization (HEMI-SYNC) phenomenon. The MIAS Hemi-Sync process makes use of the fact that each ear sends its dominant nerve signal to the opposite brain hemisphere. Sending separate sound waves to each ear (using headphones to isolate one ear from the other) causes the halves of the brain to act in union to "hear" a third signal which is the difference between the two signals in each ear. This difference is never an actual sound, but is an electrical signal that can only be created by both brain hemispheres acting and working together.[2]

The MIAS sleep inducement technology used in the SRT combines the Hemi-Sync and FFR effects to produce a highly effective sleep discipline training process. With adequate training, the soldier should be able to achieve a deeply restorative sleep/rest cycle as short as thirty minutes.

The MDEC/MIAS SRT permits training an individual to go into a sleep/rest cycle without the use of drugs, hypnotism, alcohol, or electrical stimulants. The person using the system is always in complete control and does not experience the undesirable side effects associated with the other techniques mentioned above.

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[2]Gerald Oster, "Auditory Beats in the Brain," Scientific American, October 1973.

To expedite evaluation of the MIAS sleep inducement approach under Army field conditions, a demonstration model SRT will be employed. This will require colocation of the soldiers undergoing sleep training for evaluation purposes. However, it is anticipated that the Army will use later personal models of the SRT to phase in the MIAS sleep inducement process at the basic training level. Approximately twenty hours (2 hours/day for 10 days) of sleep inducement training will be required. Once a soldier learns the technique he will not require the system in the field except for some periodic (2 hours quarterly estimated) reinforcement. It is expected that the ultimate sleep training regimen to be used as standard Army practice will be derived through subsequent Army field testing.

The personal model SRT will permit the Army to provide in-place sleep training to present Army personnel without the need for regrouping. With a minimum of instruction, leaders in basic training, field operations, special services, and other areas can include the process for both groups and individuals. Further, such units can be retained at various operational sites or by the individual soldier for reinforcement of sleep restorative training if and when needed.

3. Hardware Development and Field Evaluation Program Summary - The Army SRT program envisioned by the MDEC/MIAS team divides naturally into two time-sequential phases. The first phase encompasses the conversion of the time-proven MIAS binaural sleep inducement technology into hardware suitable for demonstration and evaluation in a limited field training environment. The hardware development tasks will be performed by MDEC with MIAS providing a technical consultation function to the hardware development team. The output

of this first phase of the program will be a demonstration model SRT. The functional and hardware descriptive details of this model are provided in Section 4 herein.

During the hardware development phase, MIAS will conduct the necessary planning and coordination with the Army in preparation for the second phase field evaluation and demonstration of the SRT. Subsequent to delivery of the SRT model by MDEC, MIAS will assist the Army in evaluating and demonstrating the SRT in a training environment at Ft. Lewis, Washington, or another suitable site. Details of the field evaluation program as they are presently envisioned are presented in Section 5 of this proposal.

4. SRT Demonstration Model Description - Design details herein are representative of the functions to be performed. They are subject to change during the development phase.

4.1 Overview - The MDEC demonstration model SRT will be used to demonstrate and evaluate, in Army field training conditions, the MIAS Hemi-Sync sleep inducement training methodology. It is a completely solid-state electronic unit using microprocessor techniques to recreate specific sound patterns and human voice in the variable, preprogrammed sequence employed in the MIAS sleep training process.

The demonstration model SRT does not represent the ultimate in miniaturization or human factors application. Instead, it has been specifically designed for training of up to twenty soldiers in one location simultaneously to facilitate the Army field demonstration and evaluation. However, the electronics design approach used was chosen so that the SRT unit in its final form can be made into a self-contained headset. This will permit the practical insertion of the MIAS sleep restorative techniques at any level of Army function.

4.2 Functional Description - The MDEC-designed SRT uses solid-state memories and microprocessor technology to produce the required binaural and stereo audio stimuli required for the MIAS sleep inducement training process. The audio stimuli contains binaural voice, binaural random noise, and stereo sine wave tone pairs.

The voice output capability consists of a three-second phrase of full inflection voice and approximately twenty, one-half second long words of constant pitch which are strung together in various orders. The three-second phrase and isolated words will be recorded by a speaker selected during the design phase.

The binaural noise output spectrum covers the range from 70 Hz to 9 kHz. Its amplitude versus frequency characteristic is shaped to compensate for the frequency response of the human ear. The peak output noise power level is a function of time as shown in Figure 1. The time axis scale factor of the amplitude versus time pattern shown in Figure 1 is selectable by the operator. The total cycle length can be varied from five to ninety minutes in discrete steps.

The SRT sine wave tone outputs are provided in stereo pairs which are separated by precise frequency differences. More than one tone pair may be present at the output at a given time. The tone pair amplitudes are functions of time as shown in Figures 2 and 3. As in the case of the random noise, the time axis scale factor for the tone pair amplitude versus time patterns shown in Figures 2 and 3 are operator selectable.

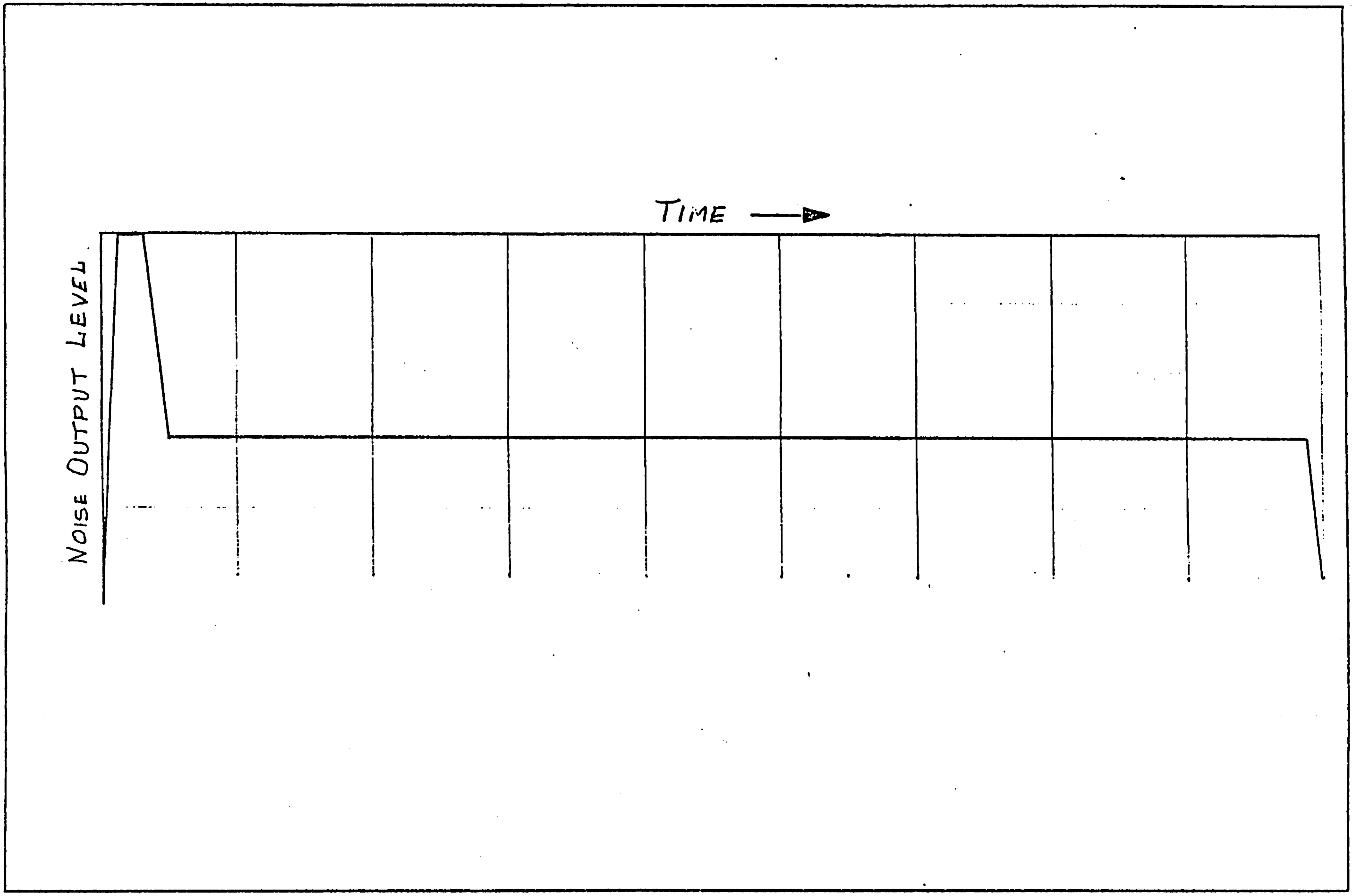


FIGURE 1. Noise Output Power Level Time Sequence

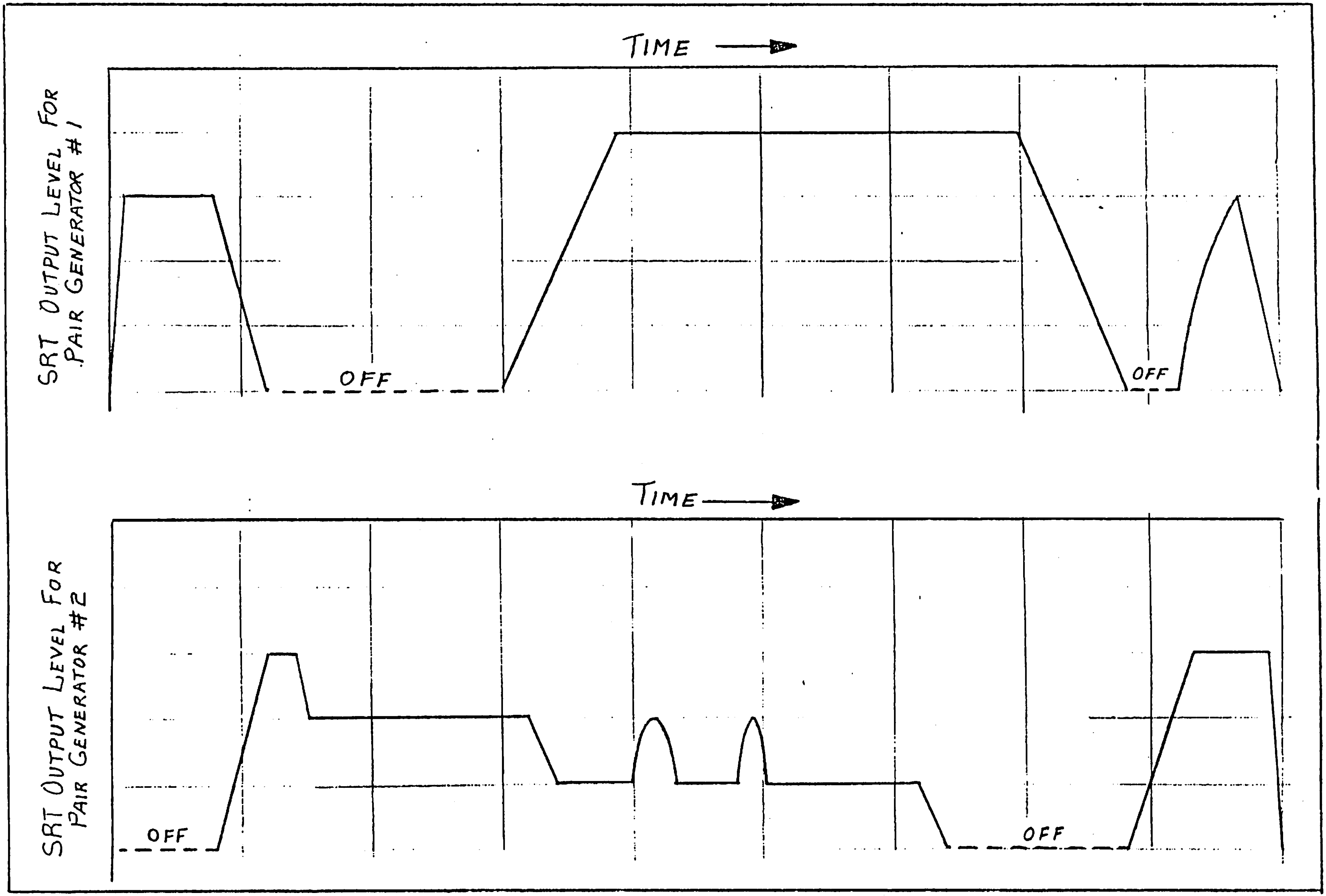


Figure 2. Output Level Time Sequence of Tone Pairs #1 And #2

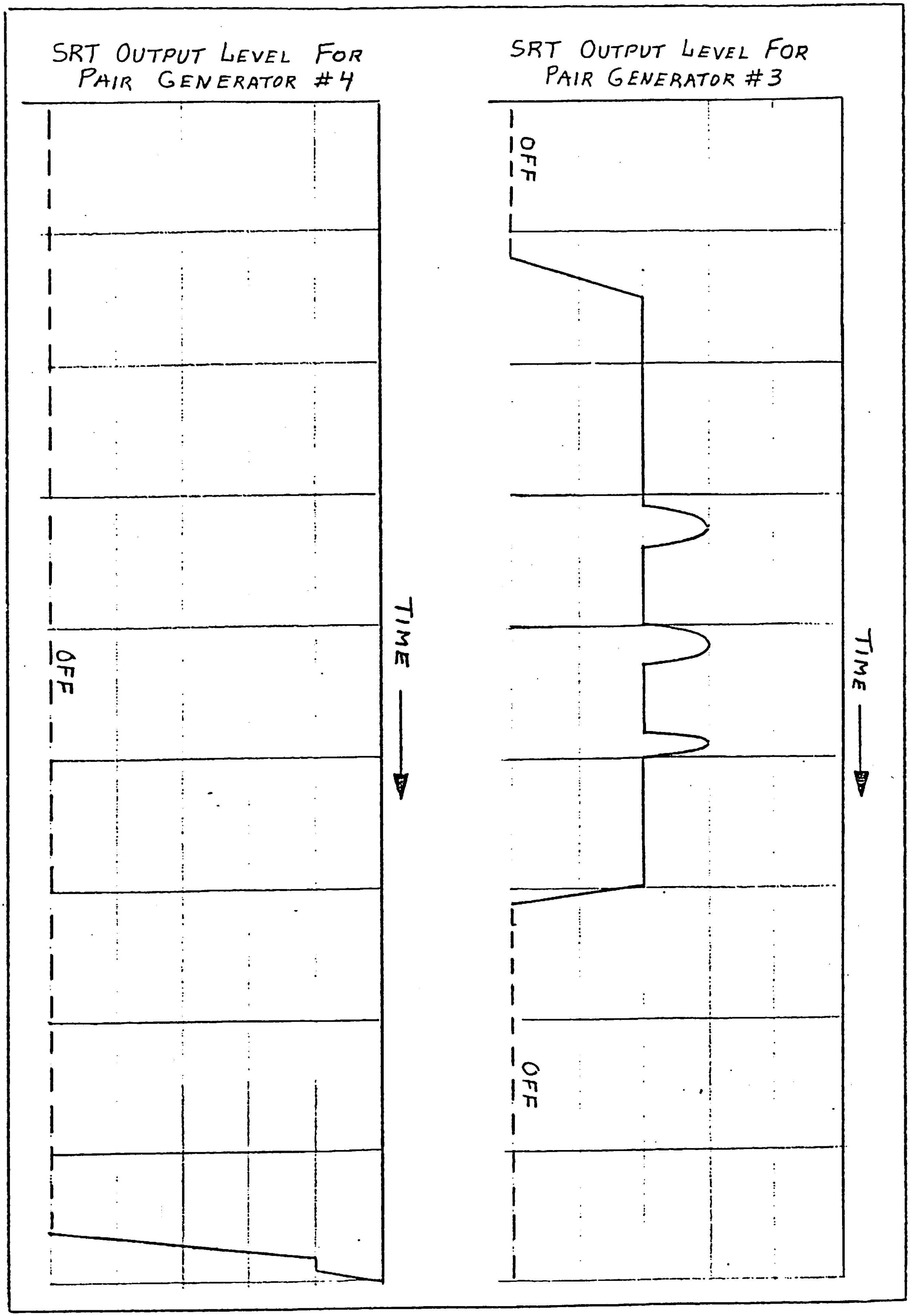


Figure 3. Output Level Time Sequence of Tone Pairs #3 And #4

The SRT is equipped with volume and balance controls which vary the loudness of the sound delivered to both ears and the relative volume of discrete composite signals in each ear. The SRT also has a start/stop function which provides operation through the complete time cycle or a one-minute "wakeup" termination of the cycle when the stop function is activated.

A simplified block diagram of the SRT unit is shown in Figure 4. Under microprocessor control, the voice information, which is stored in digital form in the voice memory, is sent to a digital-to-analog converter (DAC) and from there to each of the output amplifiers. The peak value of the output voice signal has been selected to be equivalent to the peak value of a 0 dBm sine wave.

The noise output is derived from a solid-state diode to insure that the noise is completely random. It is amplitude modulated under microprocessor control using amplitude information stored digitally in the modulation wave memory.

The clock generator produces nine different frequency clock signals which are fed selectively to the four amplitude-modulated difference pair generators. The frequencies are crystal-controlled for accuracy and stability.

The clock signals are converted into sine wave pairs in the four amplitude-modulated difference pair generators. The amplitudes of the sine wave pairs, like that of the noise, are under microprocessor control using digital information stored in the modulation wave memory.

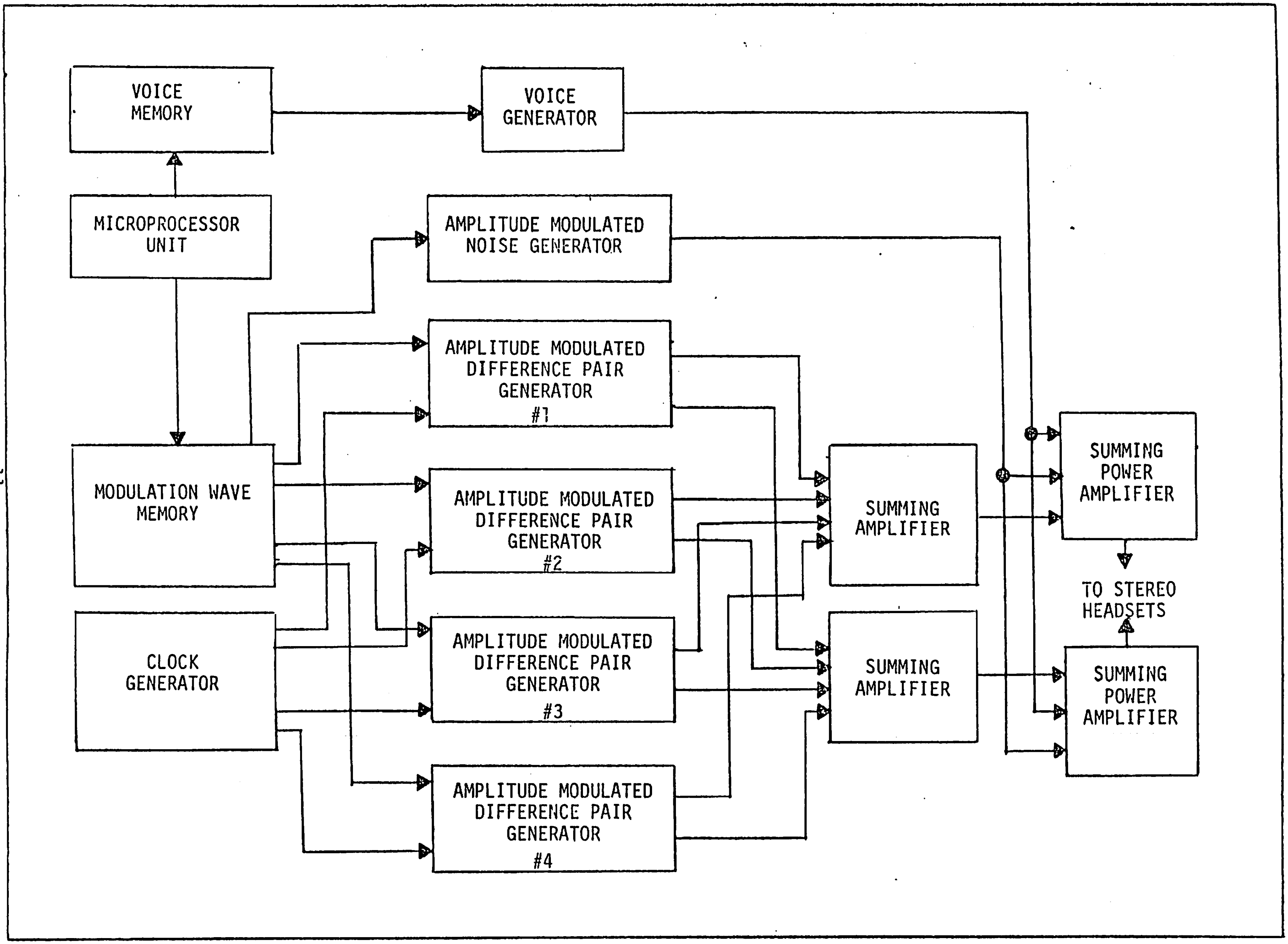


FIGURE 4. Sleep Restorative Trainer (SRT) Block Diagram

4.3 Electrical Description

4.3.1 Microprocessor Unit - The RCA 8-bit, 1802 CMOS microprocessor has been selected for use in the demonstration model SRT. It is a low-power unit which will be suitable for use in later model battery-powered SRTs. Presently, this type device is being used by MDEC for a similar application in a voice warning unit for the Douglas DC-9-80 aircraft.

4.3.2 Memories - The SRT uses both read only memory (ROM) and random access memory (RAM). The ROMs are electrically programmable, ultraviolet erasable devices which will readily accommodate any changes as the voice vocabulary is established during the design phase. They are CMOS devices with low power drain in both the active and standby states. An

additional "powerdown" feature, wherein power is applied to the memories only when they are being addressed, is employed to further reduce power consumption.

The three-second full inflection speech phrase will be sampled at 8000 samples per second, each sample quantitized to an 8-bit level, and the results stored in digital form. A total of 192K bits of ROM will be allotted for this purpose. The isolated-word voice will be processed using MDEC's MAVIS Ⓣ speech compression algorithm. A total of 320K bits of ROM will be used to store the equivalent of twenty, one-half second long words.

Minor additional ROM and RAM will be employed to store the amplitude modulation patterns, the microprocessor program, and temporary microprocessor computational results.

4.3.3 Clock Generator - The block diagram of the clock generator is shown in Figure 5. It contains four oscillators and associated dividers which provide the nine clock signals needed by the difference pair generators. The clock signals are each eight times higher in frequency than their corresponding sine waves produced by the difference pair generators.

The oscillators are designed around micropower, tuning-fork, quartz crystals and CMOS inverters to achieve low power consumption and high frequency accuracy and stability. The dividers are also constructed with CMOS devices.

4.3.4 Voice Generator - The voice generator converts the stored digital voice data into analog form. It consists of an 8-bit digital-to-analog (D/A) converter and operational amplifier combination which uses CMOS devices for low power consumption. A D/A compatible with single-polarity power supply operation is used to accommodate battery operation of later model SRTs.

4.3.5 Noise Generator - Figure 6 depicts the block diagram of the noise generator. A solid-state diode biased in the reverse voltage breakdown region serves as the noise source. It is followed by several amplifier-filter stages to raise the diode output noise to a useable level and to shape its spectrum to compensate for the frequency response of the ear. The noise spectrum range covers 70 Hz to 9 KHz.

An 8-bit multiplying digital-to-analog converter, controlled by the microprocessor, follows the amplifier-filter stages. The converter

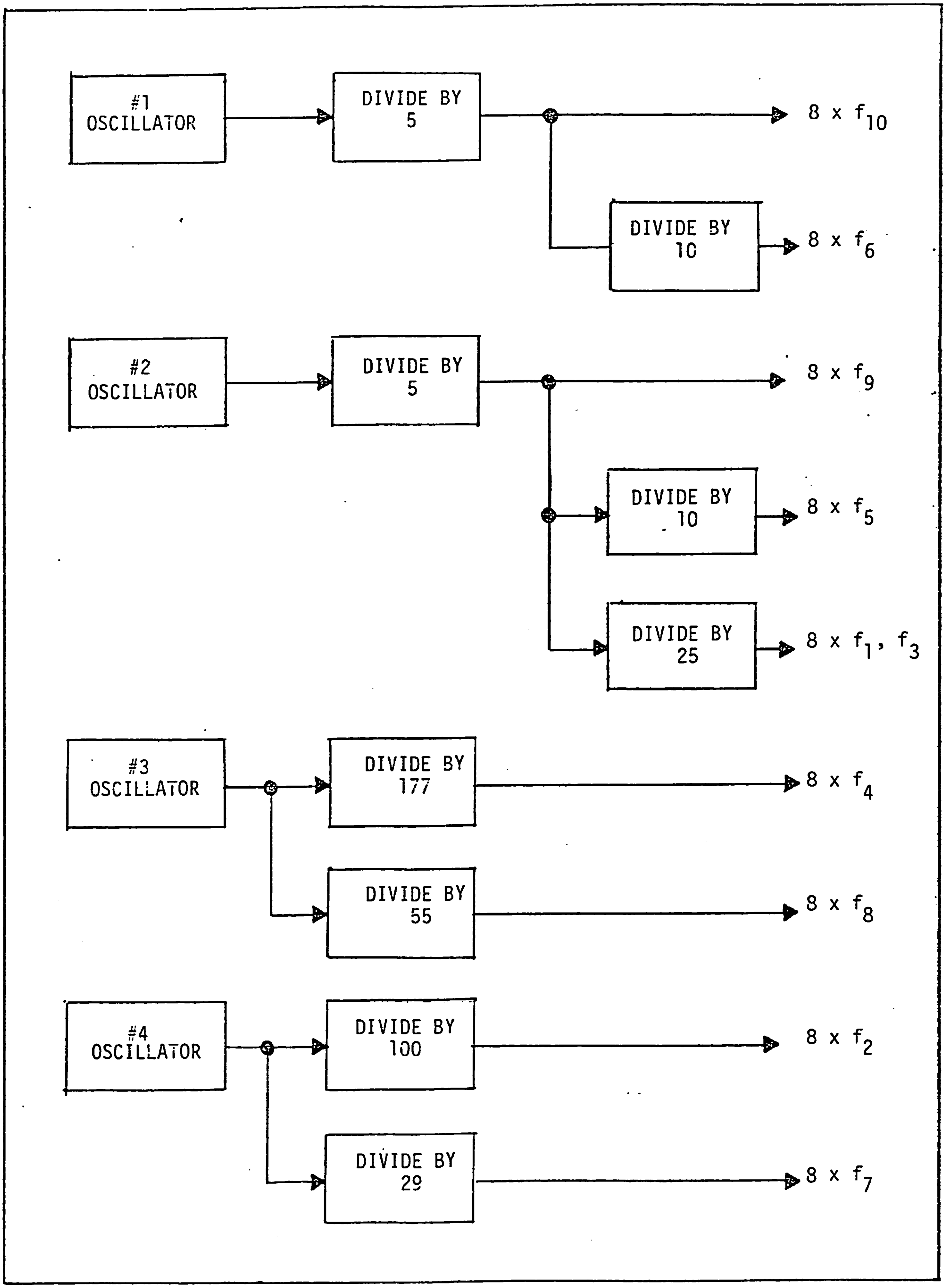


FIGURE 5. Clock Generator Diagram

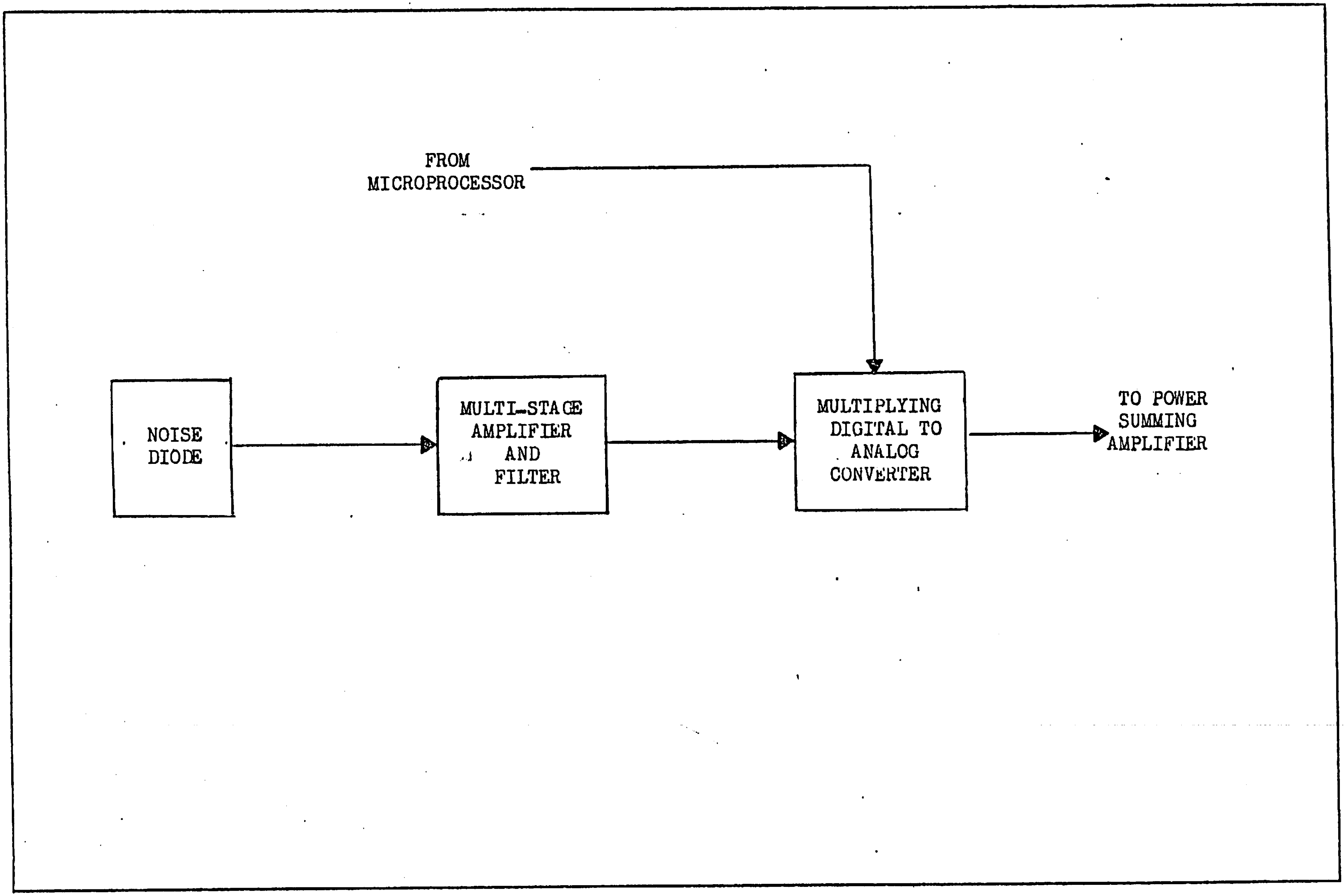


FIGURE 6. Noise Generator Block Diagram

varies the noise output level in 1 dB or smaller steps over the upper 30 dB of its range and provides progressively larger steps as the level falls below this range. This characteristic is illustrated in Figure 7.

Use of a pseudorandom code generator as the noise source was considered. However, two major drawbacks militated against its selection. First, such a generator is digital in nature and provides rectangular pulses at its output. With this source signal shape it is extremely difficult to achieve the desired Gaussian amplitude distribution over the multi-octave bandwidth required in this application. Secondly, pseudorandom noise tends to have a noticeable periodicity which detracts from the aural effects being sought in the SRT.

4.3.6 Amplitude Modulated Difference Pair Generators - The difference pair generator receives clock signals from the clock generator and converts these into sine wave pairs which are fed to the summing amplifiers. The generator block diagram is shown in Figure 8.

Each of the incoming clock signals, which are at eight times the frequency of the output sine wave, are fed to an eight-stage ring counter. Each stage of the ring counter drives an analog gate (switch) which is connected to a tap on a resistor-divider network. The resistor-divider network is driven by a voltage derived through use of a digital-to-analog converter. The tap points on the divider network are such that, as the gates are sequentially operated by the ring counter, the sampled sine wave illustrated in Figure 9 is generated at the amplifier-filter input. The lowest frequency component of this wave, other than that at the

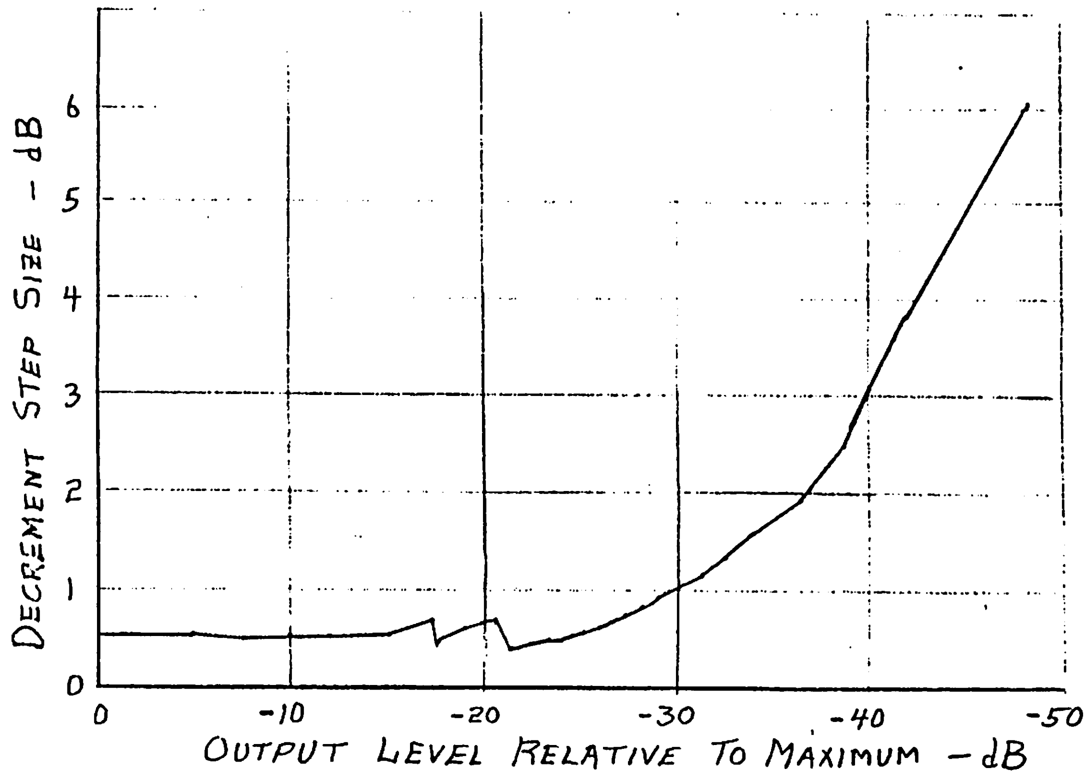


FIGURE 7. Output Amplitude Step Levels As A Function Of Output Level

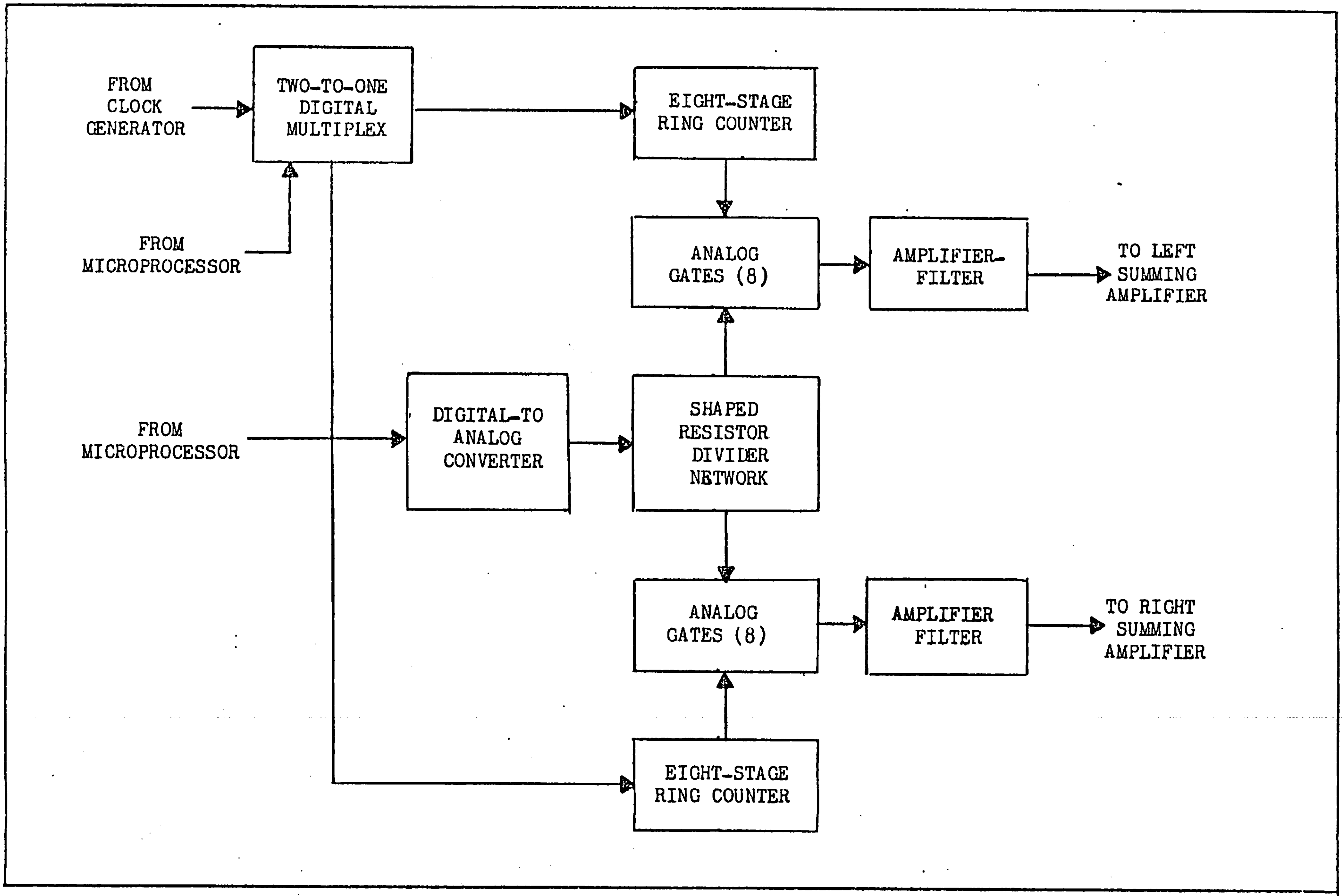


FIGURE 8. Difference Pair Generator Block Diagram

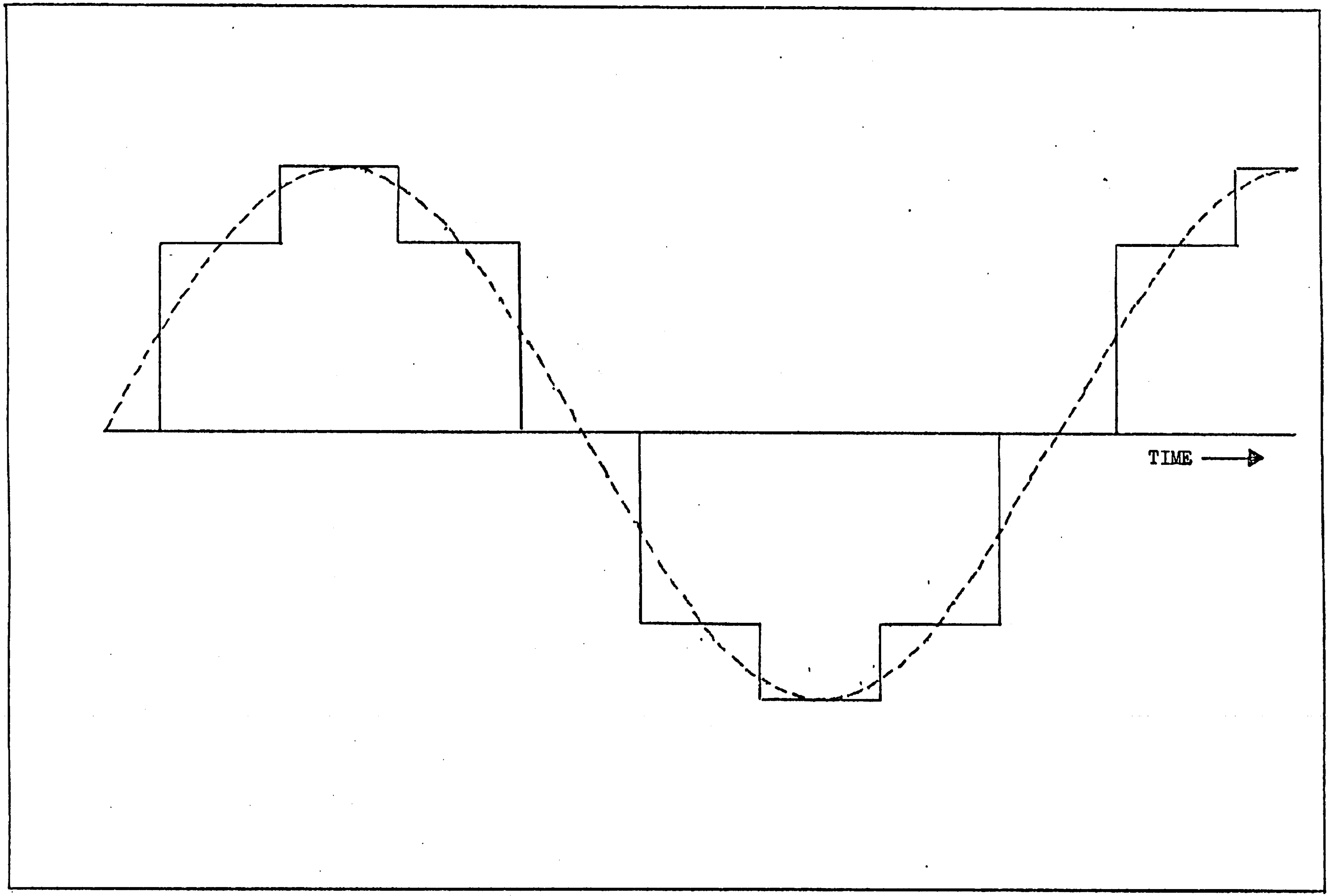


FIGURE 9. Sampled Sine Wave Signal

desired sine wave frequency is at the seventh harmonic of the sine wave. This makes removal of the undesired components relatively easy.

The digital-to-analog converter providing the resistor-divider network reference voltage is operated under microprocessor control to vary the sine wave amplitude in the desired preprogrammed sequence. The single converter controls the amplitude of both sine waves in a pair identically.

A digital 2:1 multiplexer is used ahead of the two eight-stage ring counters in one of the difference pair generators. This allows the one generator to produce, at different times, two separate sine wave pairs. This economy of circuitry is possible because the two particular pairs are mutually exclusive on a time basis in the SRT application.

4.3.7 Summing Amplifiers - Four summing amplifiers are used in the SRT. Two are used to sum separately those sine wave signals which go to only one ear of the user. The remaining two are used to sum, with the individual stereo signals, the noise and voice signals which go to both ears of the user. Careful design is required to preserve the stereo effect.

The first set of amplifiers provides only a summing function and uses low-level devices. The second amplifier set provides the power handling capability to drive the headset(s). The demonstration model amplifiers are designed to drive up to twenty headsets simultaneously. This capability is provided to accommodate the particular SRT usage conditions anticipated for the Army demonstration and evaluation program. Later personal models of the SRT will be designed to drive only one headset.

4.3.9 Headsets - High quality consumer-grade stereo headsets will be used for the exploratory development model demonstration and evaluation. These will be equipped with individual level controls for each ear. The headsets will be essentially identical to those customarily used in other applications of the MIAS process.

4.3.10 Power Supply - The demonstration model SRT will be equipped with a transformer-isolated power supply operating from standard 115 VAC commercial power. Power supply output voltages of +6 volts and +12 volts will be used to facilitate later transition to battery operation in personal models of the SRT.

4.4 Mechanical Description - As a cost saving measure the SRT will be implemented with previously developed or standard hardware wherever feasible. The microprocessor and its support circuitry will be packaged on a multilayer printed circuit board previously designed for the DC-9-80 aircraft central aural warning set (CAWS). Likewise, the memories will be packaged on a printed circuit board designed for the CAWS. The voice generator, noise generator, difference pair generators, and the audio amplifiers will be packaged on "stitch weld" and/or double sided printed circuit boards.

These boards will be assembled together as one subunit with point-to-point wiring used to interconnect between boards. The board assembly and the power supply will be contained in a "Bud" metal case with cover. The on/off, volume, start/stop, balance, and sequence time controls will be available on the top of the box. Twenty audio jacks will also be provided on one side of the unit for connection of up to twenty headsets. Total unit weight of the demonstration model is expected to be less than 15 pounds.

5. Field Testing and Demonstration

5.1 General Considerations - The MDEC/MIAS team proposes that the sleep training technology be demonstrated to and evaluated by HTTB personnel at a location and within a schedule mutually agreeable to HTTB and MDEC/MIAS. It is recommended that the demonstration and evaluation be conducted within a continuous combat operations simulation that runs long enough to clearly demonstrate the effects of prolonged sleep loss. Individual exercises such as the Command Post Exercise (CPX), the Field Training Exercise (FTX), or Army Training and Evaluation Program (ARTEP) or a combination of them would be suitable if they can be adapted to run continuously for 96 hours or longer. Evaluation participant groups should include the battalion commander, battalion staff, company commanders, commanding grade officers, and senior NCOs.

It is important to note that an exercise scenario of known performance standards or measures of effectiveness (MOE) will greatly assist in evaluation of this methodology. It is the intent of this demonstration to prove practical and usable results. Therefore, every effort should be made to allow both soldiers and observers to interpret the real impact of this technology toward improving operational effectiveness in completing their assigned missions. Unit effectiveness as well as individual performance are of primary importance.

5.2 Evaluation Plan Preparation - Preparation of the training evaluation plan will be done by MIAS in cooperation with HTTB personnel. The MDEC design team will be available for consultation in hardware setup and usage areas.

Key milestones in the plan preparation are:

a. Selection of the type exercise (CPX, FTX, or ARTEP) to be used and modification of the exercise, if needed, to meet continuous operations requirements.

b. Front-end analysis of exercise scenario.

c. Development of sleep discipline/exercise scenario interaction.

d. Refinement of sleep effects demonstration format.

e. Refinement of evaluation criteria incorporating HTTB standards.

f. Identification and random designation of Army personnel who will be test exercise participants.

g. Identification and designation of control and evaluation group personnel.

h. Establishment of final timetables and schedules for advance training, evaluation exercise, evaluation analysis, and final report.

5.3 Evaluation Group Selection and Preparation - It is proposed that three separate groups of twenty persons each be evaluated in identical, simultaneous exercises. One group would be prepared for the evaluation exercise by sleep inducement training using the MDEC/MIAS SRT technology while the other two would use alternate methodology. The latter two groups would act as comparison control groups to show individual and group variation in sleep patterns and to provide strong evaluative and comparative data against the SRT-trained group.

Preevaluation preparation of each group will be as follows:

a. The SRT group will receive approximately 20 hours

(2 hours/day for 10 days) of advance training using SRT technology limited to sleep/rest discipline.

b. The second group will receive no advance training but will employ predetermined traditional sleep/rest scheduling. However, this must conform to the training scenario time requirements for all three groups.

c. The third group will be given no advance training in sleep discipline. Instead it will be given a motivational leadership and positive attitude statement such as, "We expect you to do a good job. Sleep, rest, or relax whenever it can be done without compromising your missions."

Conditions applicable to all three groups include:

a. Any group participant experiencing personal problems or obvious discomfort will be released to his/her unit control.

b. Orientation to the three groups will also be presented for all other evaluation personnel.

c. Each group will have a normal operational identity with full instructions as to the quality and nature of the training scenario to be followed.

d. The role of outside research/evaluation personnel will be geared to minimize their presence.

As the program develops, other considerations may be employed to assure that the three groups start the exercise on a common baseline.

5.4 Evaluation Approach and Criteria - This proposal is based on evaluation of the MDEC/MIAS SRT sleep discipline approach at HTTB/Site Location by Army personnel with MIAS assistance. The demonstration program is geared to provide practical effects data rather than quantifiable physiological and biomedical data. The accumulated workability history, through 45,000 individual-use tests since 1970, of the MIAS general concept and methodology places it well beyond the point where further research data is required. Only its adaptability to Army use needs confirmation. Therefore, while biomedical monitoring equipment such as EEG and biofeedback indicators will be used to demonstrate the primary physiological effects of the MDEC/MIAS SRT methodology, precise quantification of biomedical impact is not considered to be part of this effort.

The proposed evaluation process is designed to measure how well the MDEC/MIAS SRT methodology extends the physical, mental, and emotional endurance of individuals deprived of normal sleep. The evaluation process will include:

a. EEG Primary Effects Monitoring
b. Biofeedback Effects Monitoring
c. Standard Anxiety Level Measurements
d. Standard Alertness Tests
e. Control Group Performance Comparison
f. Structured Self Reports
g. Structured Monitor Observation Reports
h. Command Group Subjective Evaluation
i. Individual Soldier Subjective Evaluation
j. Standard Performance Criteria (MOE's)
k. Other behavioral measures linked to military performance standards

Immediately prior to and during the exercise, a limited number of subjects will be selected from each of the three groups of soldiers to participate in Electroencephalogram (EEG) and Biofeedback Monitoring. The subjects will be fitted with sensor devices for passive monitoring of the primary effects of sleep loss or rest. The essentially non-intrusive sensors and monitors will permit the subjects to perform their regular training exercise tasks. This monitoring will give the evaluators a feel for measurement patterns of wakefulness, certain sleep patterns, and stress reactions to various stimuli. No attempt will be made by contractors nor is it intended that any attempt be made by HTTB to scientifically quantify these measures with Biomedical Impact on the subjects. The purpose is to be illustrative only to assist evaluators in determining the <u>practical effects</u> of the SRT technology in offsetting the impact of sleep loss and stress.

Two standard tests for alertness and for anxiety will be given to exercise subjects at various times during the demonstration exercise. The results of these tests should provide evaluators with backup data to support observation conclusions.

Control Group Performance Comparison will offer evaluators a strong tool with which to measure SRT effectiveness. The performance of the group of 20 soldiers trained to use the technology can be observed and compared directly against the performance of their counterparts in the two other groups using other sleep discipline methodology.

Structured Self Reports will be requested from all soldier participants. Those reports will incorporate questions that would tend not to be answered by the Individual Soldier Subjective Evaluation which will also be requested. It is expected that the data contained in these reports will be relatively consistent and will reasonably correlate with data from other evaluation measures. It is also the opinion of MIAS that subjective user data obtained from professional soldiers and command groups will have a high degree of validity and should weigh heavily in Practical Performance ratings.

Structured Monitor Reports will be completed by all military and contract observers. The specific requirements of these will be negotiated with HTTB but they are intended to (1) provide a commonality of view from all evaluators and (2) focus on those items of interest that would tend not to be uniform from the various individual critique formats. Every effort will be made to reduce duplicative analysis.

Command Group Subjective Evaluation like the Individual Soldier Subjective Evaluation mentioned earlier will be unstructured reports intended to address the practical results of the SRT methodology and the other sleep/ rest techniques used by the other two groups. The data resulting from this measure will be extremely useful in interpreting or augmenting data from Standard Performance Criteria (Measures of Effectiveness). Ideally, standard evaluations or MOE's will be available for the operational elements of the demonstration selected. Should these not be available or developable, even greater reliance will be placed on the opinions expressed in the Command Group evaluations.

Taken together, the above mentioned evaluation processes should result in a balanced effectiveness evaluation of the MDEC/MIAS SRT Sleep/Rest discipline methodology as it has been adapted to Military Continuous Operations requirements. This evaluation should be quantifiable in percentage increases in practical effectiveness. MIAS experience with civilian application indicates that a 20% or more effectiveness increase may be possible.

5.5 Evaluation Program Coordination - MIAS/MDEC will furnish on-site at either Ft. Lewis, Washington, or another suitable evaluation location, at a date mutually agreed upon by HTTB and MDEC/MIAS, all materials, hardware and technical personnel necessary to accomplish SRT sleep discipline training, demonstration, evaluation, and final report. MIAS/MDEC will also provide orientation and/or training to Army HTTB counterpart personnel for above listed evaluation elements.

The Army HTTB is expected to provide advance planning and coordination management personnel to work with MDEC/MIAS in the evaluation program planning and execution.

6. Schedule - The delivery schedule for the items covered by this proposal is presented in Table 1.

7. Data - As part of the effort covered by this proposal, the contractors will furnish to the Army the following data:

a. Monthly Letter Progress Report

b. Field Demonstration and Evaluation Plan

c. Final Technical Report — Exploratory Development Model SRT

d. Final Technical Report — Field Evaluation

The above data will be prepared and supplied in contractor's format.

8. Government Furnished Equipment and Support - The following government furnished equipment/facilities and support are necessary to the successful completion of the contract:

a. Army Training Exercise - Details of the training exercise selected by the Army for evaluation of the SRT technology must be made available to the contractor ten weeks prior to the actual beginning of the evaluation exercise.

b. Army Liaison Personnel - The Army must assign a receptive technical person from HTTB who will support the program and provide the focal liaison point with the contractor for development and implementation of the evaluation program.

c. Evaluation Groups - Three groups of 20 Army personnel each must be made available as cooperative subjects for the evaluation exercise.

d. Instructors - The Army HTTB will assign instructors to work with two of the groups while the contractor works with the third group.

f. Evaluators - The Army HTTB will assign suitable personnel to monitor and report the performance of the trainees in the three groups. The contractor will have free access to the evaluators for conferences, debriefings, etc., as required.

TABLE 1

SLEEP RESTORATIVE TRAINER DELIVERY SCHEDULE

ITEM	QTY.	DESCRIPTION	DELIVERY
1	1	Exploratory Development Model SRT	6 1/2 months ARO
2	1 lot	Monthly Progress Letter	1st submittal 45 days ARO, monthly thereafter
3	1 lot	Field Demonstration and Evaluation Plan	20 days prior to later of: a) Item 1 delivery b) Commencement of field evaluation exercise
4	1 lot	Final Technical Report - SRT Exploratory Development Model	7 months ARO
5	1 lot	Final Technical Report - Field Evaluation	60 days after field test completion

g. <u>Office and Conference Facilities</u> - For one month prior to and throughout the duration of the training/evaluation exercise, the Army will make available, at the exercise site, private office space and suitable office furniture to accommodate two contractor personnel. Additionally, the Army will provide conference facilities for contractor briefings of Army trainers, evaluator, trainees, etc., on the scope and goals of the program.

9. <u>Program Organization/Management and Personnel</u> - McDonnell Douglas Electronics Company (MDEC) and Monroe Institute of Applied Sciences have jointly entered into a teaming arrangement to perform the tasks described in this proposal. On this program MDEC will function as the prime contractor, exercising the management function, and MIAS will fill the role of an associate contractor. The demonstration model SRT will be designed, built, and delivered to the Army by MDEC. With Army cooperation, MIAS will prepare the evaluation plan, conduct the sleep training portion of the SRT field evaluation, and generate a final report on the results of the evaluation. MDEC will provide appropriate assistance during the evaluation.

The SRT demonstration model design and construction will be performed by the Avionics and Support Department of MDEC at St. Charles, Missouri. The MIAS portion of the program will be conducted at MIAS headquarters in Nellysford, Virginia, and on-site at Ft. Lewis, Washington. Resumes of the MDEC and MIAS personnel designated to participate in this program are included in Appendix 1 of this proposal.

10. Patents and Proprietary Information - The sleep inducement process proposed here is covered in part or whole by MIAS-owned Patent #3,884,218. MIAS has previously licensed Metronics Systems, Inc., to merchandise the technology in cassette tape form in the consumer market.

The functional operation and design of the SRT as described in this proposal are considered by MDEC to be proprietary information not to be disclosed outside the Army without prior MDEC approval.

APPENDIX 1

KEY PERSONNEL

FOR

SLEEP RESTORATIVE TRAINER

DEVELOPMENT

AND

FIELD EVALUATION

BIOGRAPHY

QUENTIN F. VEIT

Position Branch Manager, MDEC

Education 1956-1961 Graduate Study, Electrical Engineering, University of Pennsylvania
1954 B.S. Electrical Engineering, University of Missouri

MDC Experience Mr. Veit is presently engaged in IRAD tasks involving the the F-15E HUD, aural warning systems, and F-15 data link enhancement.

Prior assignments included:

- Design and development of F-15 Data Link and DC-9-80 Central Aural Warning System.
- Proposal preparation and preliminary design for the F-18 HUD, F-18 Up Front Control Panel, and F-18 Maintenance Signal Data Recording System, F-15 Data Link plus a miniaturized encryption equipment for NSA.
- Review and recommend methods for improvement of Army maintenance of CEFIRM RF equipment at Ft. Bliss, Texas.
- Design supervision for a 250 watt solid-state, 690 to 1000 MHz transmitter-duplexer.
- Design supervision for a 500 watt solid-state transmitter and its companion jamming modulation generator for the Army CEFIRM system.
- CEFIRM system integration.
- Initial equipment design for EROS II Collision Avoidance System.
- Communications transceiver IRAD and proposals.
- Responsible Engineer for the F-4 Decode Display Coupler design.
- Equipment and system analysis for EROS I Collision Avoidance System.

Other Experience 1954-1963. Mr. Veit was employed by Philco Corporation, Communications and Weapons Systems Division. He was Senior Engineering Specialist serving as staff consultant in the Communications Facilities Laboratory. In earlier assignments, he managed the design of the following items: line-of-sight and tropospheric scatter microwave communciations equipment; PAM, SSB, and AN/TRC-56 AM voice multiplexing equipment and systems.

Memberships Mr. Veit is a member of Tau Beta Pi, Eta Kappa Nu, and Society for Information Display.

BIOGRAPHY

THOMAS G. SCHMIDT

Position Principal Staff Engineer, MDEC

Education 1959 B.S. Electrical Engineering, University of Missouri

MDC Experience Mr. Schmidt has 22 years' experience at MDC. His experience is primarily associated with the application of digital design techniques to equipments and systems in many disciplines. These disciplines include: Video Display Generation, Automatic Fingerprint Identification, Electronic Warfare, Wind Energy Conversion, Avionics, and Avionics Support.

Mr. Schmidt presently directs the design activity which applies state-of-the-art technology to reconnaissance film annotation. He is additionally responsible for implementing the texturing function associated with visual simulation scene generation. Immediately prior to this activity, he directed the design of a CMOS/SOS pipelined divider LSI circuit. This circuit permits 10 MHZ division and is utilized in the MDEC VITAL texturing function.

Memberships Mr. Schmidt is a member of Tau Beta Pi, Eta Kappa Nu, and Pi Mu Epsilon.

BIOGRAPHY

VERNON D. DUNN

<table>
<tr><td><u>Position</u></td><td>Staff Engineer, Electronics, MDEC</td></tr>
<tr><td><u>Education</u></td><td>1972 M.S. Electrical Engineering, University of Missouri at Rolla
1960 B.S. Electrical Engineering, University of Missouri at Rolla</td></tr>
<tr><td><u>MDC Experience</u></td><td>1973-1982. Mr. Dunn is responsible for developing the airborne voice warning family of products. Responsibilities include proposals, development of engineering plans, logic design, and voice synthesis.

1968-1972. Mr. Dunn was responsible for developing a Time Correlation Unit for the Sky Lab program. Earlier, Mr. Dunn was the responsible engineer for the EROS II Collision Avoidance Computer Unit used in test and evaluation.

1962-1967. Responsibilities included design and development of the telemetry section of the Airborne Digital Computer adapter and the Aerospace Ground Equipment for the Rate Gyro for the BGRV program, design of digital circuits for the ASW21A Data Link Adapter, and development of the Environmental Coolant Loop and Temperature Simulation of the Gemini Mission Simulator which encompassed hardware and software activities. Initially, he was involved in the development of the Gemini Time Reference System and special test equipment for the Gemini Project.</td></tr>
<tr><td><u>Other Experience</u></td><td>1960-1962. At Autonetics, Mr. Dunn was assigned to the development of the analog switching drawers, coder-decoder drawer, and computer coupler drawer of the Minuteman Missile Guidance and Control Console. He also worked on reliability analysis of circuits used in the base checkout equipment and the development effort on the Minuteman Universal Component Tester.</td></tr>
<tr><td><u>Memberships</u></td><td>Mr. Dunn is a member of Tau Beta Pi, Eta Kappa Nu, and Kappa Mu Epsilon.</td></tr>
</table>

BIOGRAPHY

CYRUS G. MUETH

Position Senior Staff Engineer, MDEC

Education 1960 B.S. Electrical Engineering, University of Illinois

MDC Experience Mr. Mueth has 22 years' experience in the design, development, and supervision of aerospace and ground support equipment. His present assignments include design and testing of existing contract work together with IRAD activities and new business design studies.

Mr. Mueth's present assignments include training, follow-up, and new concepts for the Data Display Set (DDS) AN/ASQ-154 used on reconnaissance aircraft. Prior to this he worked with the design, development, qualification testing, training, and manufacturing support for the DDS.

Mr. Mueth participated in the design of electronic circuitry for an Automated Test Station for the RF-4E Signal Data Converter, supervised the electronic design of the F-15 Display Unit, and assisted in the qualification and reliability testing of the F-15 Head-Up Display Set.

In 1972 he designed the analog sections of the AN/ASQ-154 (XA-2) Data Display Set and assisted in the testing, manufacturing, and delivery of this end item. Prior to this, he developed a multi-channel, solid-state, synchro-to-digital/analog-to-digital converter for use in a Data Annotation System. Mr. Mueth was responsible for the design and development of the Command Relay Driver Unit Monitor for the NASA Monitoring System, Head-Up Display for the F-15 Program and a Head-Up Display for the F-4 aircraft.

In earlier assignments, Mr. Mueth was responsible for the design, development, and qualification testing of the AN/ASM-66 Recording Camera Test Set, the AN/ASM-237 Weapons Release Computer Analyzer, the LS-61A Data Recording Camera Test Set and the Time Reference System PIA console for the Gemini spacecraft.

Military Experience 1952-1954. U.S. Signal Corps

APPENDIX "B"

PRICE BREAKDOWN

SLEEP RESTORATIVE TRAINER

PRELIMINARY PRICING

	PREVIOUS SUBMITTAL MAY 1982	PRESENT SUBMITTAL FIXED PRICE OR C.P.F.F.	
MDEC	$272,000	$282,000	$265,000
MONROE	$140,000	$170,000	$158,000
TOTAL	$412,000	$452,000	$423,000

ASSUMPTIONS:

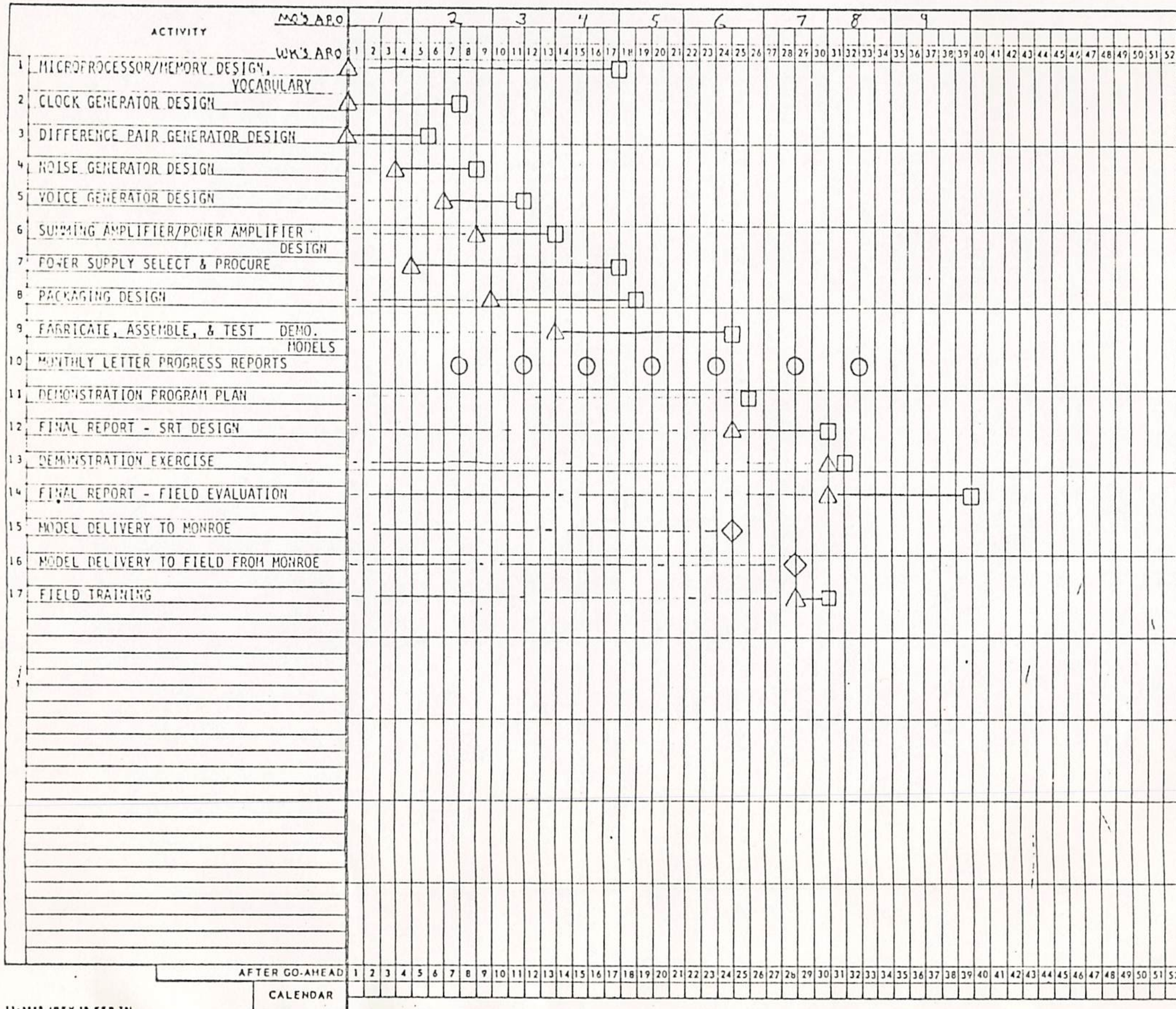
- GO-AHEAD IS 1 NOVEMBER, 1982
- PROGRAM DURATION IS 9 MONTHS
- CPFF EARNINGS @ 7.5%
  OR
- FIXED PRICE EARNINGS @ 15.0%
- NO MONROE QUOTE HAS BEEN OBTAINED

E.R. KROPP, JR
DEPARTMENT 1161

APPENDIX "C"

MASTER SCHEDULE

MCDONNELL DOUGLAS ELECTRONICS COMPANY SCHEDULE



NO. ______ ISSUE ______ PAGE ______ OF ______

REFERENCE SLEEP RESTORATIVE TRAINER

DEMONSTRATION MODEL

NOTES

LEGEND

△ START
□ COMPLETE
○ SUBMITTAL
◇ DELIVERY

COORDINATION / APPROVED

ENGINEERING ______

PROCUREMENT ______

MANUFACTURING ______

QUALITY ASSURANCE ______

PROGRAM MANAGER ______

PREPARED BY D. Earnest

ISSUED BY Engineering DATE 1 JULY 82

DEPARTMENT 1433 EXT. 4019

11-3229 (REV 10 FEB 78)